ONR-171-527

Syscom	Sponsor	Solicitation	Program
ONR	Code [redacted]	17.1	Navy SBIR

Does this topic address SYSCOM Provider Enterprise priorities?

Has this exact topic been submitted to the DoD Topic Review before? No

If yes, was it approved during the review process? No

Has this exact topic appeared in a DoD Solicitation? No

If yes, under what topic number?

Topic Text

Title

Nickel Aluminum Bronze for Additive Manufacturing Alloy Development

Technology Area

1. Materials / Processes

Manufacturing Topic

Is this a manufacturing-related topic? Yes

Affordability

Does this topic address affordability? Yes

If yes, how is the proposed technology expected to impact system-level (e.g., propulsion system, weapon system, etc.) cost in the following categories? *

(a) Acquisition: Reduction

(b) Maintenance: Reduction

(c) Manning: No Impact

(d) Operation (excluding Manning): No Impact

(e) Aggregate of the above four: Reduction

Energy Targets

SECNAV has identified five "Energy Targets", which include the demonstration of a "Green Strike Group" by year 2012; reduction of petroleum use by 50% in the commercial fleet of 50,000 vehicles by year 2015; and, by year 2020, the use of alternative energy sources for 50% of total DoN energy consumption. Towards meeting these targets, a new DoN SBIR/STTR initiative is for topics addressing one or more of the following: (i) alternative energy (e.g., solar, geothermal, wind, ocean energy; energy scavenging, landfill gas, waste-based energy), (ii) biofuels, and (iii) energy efficiency (e.g., hybrid electric power, fuel cells, high efficiency power conversion, power grid metering/smart grid, high efficiency HVAC, maintenance reduction systems, efficient propulsion systems, drag reduction coatings and appendages, anti-corrosion coatings). Please use the drop-down menu to indicate the category of your topic.

None

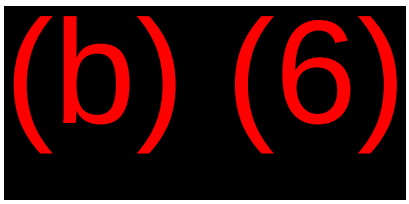
Future Naval Capability (FNC) Topic

Does this topic address an FNC? Yes

Acquisition Program, Program of Record or FNC

EPE-17-03 Quality Metal Additive Manufacturing (Quality Made)

Acquisition Program Point of Contact



Acquisition Interest

This SBIR topic directly supports the Quality Made FNC program. Quality Made has support from PEO Ships, PEO(A) and PEO (LS).

SEA 073 - Undersea Technology (Preparing for the Next Generation Attack Submarine) has identified that future geometries to achieve desired performance for the Next Generation SSN propulsor will be highly complex for conventional casting and machining of nickel aluminum bronze, a preferred material for propulsors. Alternative materials and manufacturing technologies to increase the potential design space are of interest for the Next Generation SSN propulsor.

Objective

Develop, optimize and demonstrate use of a nickel aluminum bronze (NAB) alloy composition optimized for the additive manufacturing process for large seawater components (>12"). The alloy must exceed the current mechanical and seawater corrosion resistance of cast NAB alloy C95800.

Description

The Navy extensively uses components of cast nickel aluminum bronze (NAB) in sea-water applications for their combination of strength, toughness, and corrosion resistance. Commonly used for large scale, small-production-quantity castings, NAB is challenging to consistently cast in complex geometries and in thin sections. Additive manufacturing (AM) allows for layer by layer fabrication from a digital design, and offers significant opportunities for complex geometries that may be difficult to achieve in a traditional casting.

Direct fabrication of AM components has been demonstrated with a wide variety of materials and technologies. Current bronze and copper alloys for AM often utilize post processing and impregnation for final part fabrication. There has been limited work in direct AM fabrication of bronze; however, efforts have focused on utilization of traditional casting compositions or welding analogs. Cast NAB alloys (ASTM B 148, UNS C95800) are generally slow cooled and precipitation strengthened, which may not be ideal for the rapid heating-cooling associated with direct AM fabrication. Additive manufacturing can have cooling rates >1000 °C/s and unique processing conditions due to the cyclic heating/cooling in localized areas during fabrication. Similarly, conventional welding of NAB can result in severe distortion due to residual stress and residual stresses may be further exacerbated in the AM process. Lastly, cast NAB has significant natural seawater corrosion resistance, but introduction of microstructural variation in the AM process may result in changes in corrosion behavior.

These considerations for layer by layer fabrication can be increasingly complex for large scale components >12”. To realize fully the capabilities of AM, new NAB alloys for large scale fabrication must be developed specifically for the additive manufacturing process to enhance strength and ductility compared to traditional cast NAB, while maintaining corrosion resistance.

Phase I

During Phase I, the small business will define and develop a concept/approach using computational tools for a new/optimized nickel aluminum bronze alloy composition for AM, targeting initial mechanical properties (strength,

ductility, etc.) and effects on microstructure and phase precipitation as a function of thermal processing (heating/cooling rate). If awarded the Phase I option, the small business will demonstrate the feasibility of a new/optimized composition for feedstock material amenable to the additive manufacturing process on the small coupon level.

Phase II

Based on Phase I results, the Phase II effort will develop, demonstrate and validate the proposed computational approach for new/optimized AM NAB composition(s). This will include demonstrating optimized alloy composition(s) in AM fabrication of large test builds >12" to obtain as-fabricated mechanical properties and microstructural/chemical characterization. Mechanical properties such as strength, ductility, toughness, fatigue, etc. will be tested; distortion relative to the original test build CAD drawing will be measured. Microstructural/ chemical characterization such as grain size, porosity, phase identification/quantification, precipitate formation/segregation, chemical segregation, electrochemical response, etc. will be measured for the new/optimized AM NAB composition(s). Conventional "as-cast" NAB will serve as the baseline for fabrication/processing and material property improvement. The performer shall demonstrate strength/ductility and corrosion equivalent or superior to cast UNS C95800 properties. It is recommended that the performer work with bulk material vendors/OEMs to facilitate transition for Phase III.

Phase III

Phase III will transition optimized alloy composition to commercial suppliers through bulk material vendors, OEMS, or other partnering agreement. Phase III will demonstrate AM optimized NAB alloy(s) and transition an AM technical data package to Warfare Centers and other DoD production/maintenance facilities.

Private Sector Commercial Potential/Dual-Use Applications

Nickel aluminum bronze is widely used in the maritime industry and would benefit from this material and AM technology.

References

1. Howell, Paul R. On the Phases, Microconstituents and Microstructures in Nickel-Aluminum Bronze. http://www.copper.org/publications/pub_list/pdf/A1310-Microstructures-NickelAlumBronzes.pdf

2. Wong, Kaufui V. and Hernandez, Aldo. A Review of Additive Manufacturing. doi:10.5402/2012/208760 http://www.hindawi.com/journals/isrn/2012/208760/

3. ASTM B 148 https://www.astm.org/Standards/B148.htm

Keywords

additive manufacturing; casting; bronze; nickel aluminum bronze; sea water components; alloy development

Topic Author Certification

Is this topic ITAR restricted? No

Will the resulting technology have civil applications?

Will the resulting technology have performance equivalence in civil applications?

Will the resulting technology have significant military or intelligence applicability?

Does this topic meet the DON topic criteria?

Yes

Rationale

Security Review

Are any unusual capabilities, vulnerabilities, or other sensitive critical information being revealed? No

Are there any critical items of information or indicators contained in the topic? No

Are there any risks associated with the release of any of this information? No

Are clues to sensitive information in another program included? No

Will work under this effort be classified in Phase I? No

Is it probable that the work under this effort will be classified under Phase II? (Yes is acceptable but should be noted under Phase II.) No

Is any of the information to be included in the DoD SBIR/STTR Program Solicitation classified? No

Pre-Solicitation Information

All information past this point will not be included in the solicitation and is provided only for the topic selection process. The author and contact information section will be removed after the presolicitation phase and will not go into the solicitation.

Navy Need

NAB is a naval alloy of interest heavily used in marine systems. Additive manufacturing can enable a wider design space, but is currently limited in available alloys. There has been limited work in direct AM fabrication of NAB.

Mission Capability, Performance and Life-Cycle Cost

This topic will enable increased performance through new designs that leverage AM manufacturing technology for a marine alloy.

Taxonomy

Topic Writers and Contact Information

The 1st or 2nd Author is the person who can be contacted by the small business with technical questions regarding the topic during the open discussion period. Depending on the Syscom, the first author may or may not be the final TPOC on the topic.

Topic authors MUST be government employees with a government email address.

1st Author

(b) (6)

2nd Author

(b) (6)

3rd Author

(b) (6)

4th Author

POC information correction